SYNOPSIS OF GRANTS OF MONEY appropriated to Scientific Purposes by the General Committee at the Liverpool Meeting in September 1870. The names of the members who would be entitled to call on the General Treasurer for the respective Grants are prefixed:

	£	s.	d.
Kew Observatory			
The Council.—Maintaining the Establishment of Kew Observatory	600	0	0
Mathematics and Physics			
*Brooke, Mr.—British Rainfall	50	0	0
*Thomson, Professor Sir W.—Underground Temperature	150	0	0
*Tait, Professor.—Thermal Conductivity of Iron and other Metals	20	0	0
*Thomson, Professor Sir W.—Tidal Observations	100	0	0
*Glaisher, Mr.—Luminous Meteors	30	0	0
Crossley, Mr.—Observations of Lunar Objects	20	0	0
Herschel, Sir J.—Recomputation of the Gaussian Constants for 1839	50	0	0
Stewart, Professor B.—Standard Measures of Electrical Capacity	20	0	0
Hockin, Mr.—Standard Electrodynamometer	20	0	0
Thomson, Professor Sir W.—Standard Potential Gauge	20	0	0
Chemistry			
Williamson, Professor.—Reports of the Progress of Chemistry	100	0	0
Brown, Professor Crum.—Thermal Equivalents of the Oxides of Chlorine	25	0	0
Geology			
*Lyell, Sir C., Bart.—Kent's-Cavern Exploration	150	0	0
*Duncan, Dr. P. M.—British Fossil Corals	25	0	0
*Symonds, Rev. W. S.—Sedimentary Deposits in the River Onny	10	0	0
*Mitchell, Mr. W. S.—Leaf-beds of the Lower Bagshot series	20	0	0
Thomson, Mr. James.—Sections of Fossil Corals	20	0	0
Scott, Mr. R. H.—Mesozoic Deposits of Omenak, North Greenland	50	0	0
Woodward, Mr. H.—British Fossil Crustacea	25	0	0
Busk, Mr.—Fossil Elephants of Malta	25	0	0
Biology			
*Carruthers, Mr.—Fossil Flora of Britain	25	0	0
*Sharpey, Dr.—Physiological Action of Methyl Compounds	25	0	0
*Sclater, Mr.—Record of the Progress of Zoology	100	0	0
*Foster, Professor M.—Heat Generated in the Arterialisation of Blood	15	0	0
Balfour, Professor.—Effect of the Denudation of Timber on the Rainfall in North Britain	20	0	0
Geography			
Murchison, Sir R. I., Bart.—Exploration of the Country of Moab	100	0	0
Statistics and Economic Science.			
*Bowring, Sir J.—Metrical Committee	25	0	0
	£1840	0	0

SECTIONAL PROCEEDINGS

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE

Abstract of an Investigation of the Mathematical Theory of Combined Streams.—Professor W. J. M. Rankine, F.R.S. The object of the investigation of which this is an abstract is to extend to combinations of any number of streams of fluid, whether liquid, vaporous, or gaseous, the principles which have been applied to combinations of two streams by previous authors, and especially by Professor Zeuner, in his treatise entitled "das Locomotiven-Blasrohr" (Zürich, 1863). Several component streams of fluid, each coming through its own supply-tube and nozzle, are led in directions parallel to each other, into one end of a cylindrical space called the junction-chamber, in which they mingle so as to form a resultant stream; and that resultant stream escapes from the other end of the junction chamber through an orifice called the throat. The dynamical principle upon which the motion depends is that of the equality of impulse and momentum. The aggregate momentum per second of the component streams is found by multiplying the mass of fluid which comes from each nozzle in a second by its velocity, and adding together the products. The momentum of the resultant stream is the product of the mass of fluid discharged from the throat in a second, into the velocity at the throat. The difference of these two momenta is equal to the impulse per second exerted in the junction-chamber, which impulse is found by multiplying the area of the throat by the difference between the intensities of the pressure at the nozzle end and at the throat end of the chamber respectively. If there be a gain of momentum, the pressure at the throat is less than at the nozzles; if there be a loss of momentum, the pressure at the throat is greater than at the nozzles.

There is always a loss of energy, which is expended in producing eddies; unless the velocities of the component and resultant streams are all equal to each other. The amount of that loss can be calculated in any given case, by the help of the principle already stated; and that principle being expressed in the form of an equation, and taken together with another equation expressing the equality of the mass discharged at the throat to the sum of the masses which come through the nozzles, affords the means of solving various problems as to combined streams.

Abstract of a Paper on the Thermo-dynamic Acceleration and Retardation of Streams.—Professor W. J. M. Rankine, F.R.S.* The object of this paper is to state in a more general and comprehensive form than has hitherto been done to my knowledge, a thermo-dynamic and hydro-dynamic principle of which many particular cases are well known and understood. That principle may be stated as follows:—

In a steady stream of any fluid, the abstraction of heat at and near places of minimum pressure, and the addition of heat at and near places of maximum pressure, tend to produce acceleration; the addition of heat at and near places of minimum pressure, and the abstraction of heat at and near places of maximum pressure, tend to produce retardation; in a circulating stream, the quantity of energy of flow gained or lost in each complete circuit is equal to the quantity of energy lost or gained in the form of heat; and in the absence of friction, the ratios borne by that quantity to the heat added and the heat abstracted (of which it is the difference) are regulated by the absolute temperatures at which heat is added and abstracted, agreeably to the second law of thermo-dynamics.

Amongst particular cases of the thermo-dynamic acceleration and retardation of streams, the following may be specified:—

Acceleration by the addition of heat at and near a place of maximum pressure; the draught of a furnace; and the production of disturbances in the atmosphere in regions where the ground is hotter than the air.

Retardation by the abstraction of heat at and near a place of maximum pressure; the dying away of atmospheric disturbances in regions where the ground is colder than the air.

Acceleration by the abstraction of heat at and near a place of minimum pressure; the injector for feeding boilers, in which a jet of stream, being liquefied by the abstraction of heat, is enabled not only to force its way back into the boiler, but to sweep a current of additional water along with it; also, to a certain extent, the ejector-condenser.

The conduction of heat from the parts of a stream where the pressure and temperature are highest, to the parts of the same stream where the pressure and temperature are lowest, produces, according to the foregoing principles, a gradual and permanent retardation of the stream, independently of the agency of friction; and this is accompanied by the production of heat to an amount equivalent to the lost energy of flow.

SECTION B.—CHEMICAL SCIENCE

On the Weldon Process for the Manufacture of Chlorine.—Mr. W. Weldon, F.C.S., the author, said the process was one for the manufacture of chlorine by means of a perpetually-regenerated reagent consisting mainly of a compound containing the elements of peroxide of manganese and lime, and which was previously unknown. He had described the process last year at the Exeter meeting, when it was in operation at only two works. It is now either in operation or on the point of being adopted at almost all the works in this country, and at a number of works in France and Germany. In consideration of the fact that the production of chlorine will probably be completely revolutionised by the Weldon process, and considering, likewise, that chlorine is largely prepared in the neighbourhood of Liverpool and in other parts of Lancashire, the author had agreed to the request of Prof. Roscoe that he should submit to the section a brief account of the practical results, which the process had been found to yield under more extended experience, and of the development which it had undergone during the year. The author first described the apparatus employed, and exhibited a small model of it, and then proceeded to state that the chloride of manganese, which results in the ordinary preparation of chlorine, and which is generally acid, is neutralised by adding to the liquor finely-divided carbonate of lime. The liquor then consists of a neutral mixed solution of chloride of manganese and chloride of calcium, and contains, in suspension, a large quantity of sulphate of lime and smaller quantities of oxide of iron and alumina. The clear solution, after settling, is oxidised by passing into it a blast of atmospheric air from a blowing engine, and heated, if necessary, by a current of steam. Milk of lime is then run into the oxidiser until the liquid ceases to give a manganese reaction with solution of bleaching powder. A further quantity of milk of lime is added, and ultimately from eighty to eighty-five per cent. of the manganese is converted into peroxide. The mixture is allowed to settle, the chloride of calcium solution forming the supernatant liquid is run off, and the residual black mud containing the manganese peroxide is used in the stills where hydrochloric acid is decomposed and chlorine gas produced. A residual liquor such as was commenced with, results, and the round of operations is begun again; and so on, time after time indefinitely. After giving an outline of his mode of treating still liquor, Mr. Weldon described at considerable length the details of the process, both as to quantities of materials employed and obtained, and the nature of the chemical compounds formed at different stages of the process. As explained by Prof. Roscoe, the principle upon which the process depends is that, although when alone, the lower oxides of manganese cannot be oxidised by air and steam under the ordinary pressure to the state of dioxide, yet this is possible when one molecule of lime is present to each molecule of oxide of manganese. The manganous oxide is precipitated from the still liquors with the above excess of lime, and by the action of steam and air on this, a black powder, consisting of manganese dioxide and lime, or calcium manganite (MnO_2 $Ca O$), is formed. This compound is again capable of generating chlorine from hydrochloric acid, and thus the chlorine process is made continuous with a working loss of only $2\frac{3}{8}$ per cent. of manganese.

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* Re-appointed.

* Printed in full in the "Philosophical Magazine" for October, 1870.

A short discussion followed the reading of the paper, in the course of which Mr. Gossage stated that his experiments on the improvement of the chlorine process had extended over thirty-five years, and he was glad Mr. Weldon's efforts had been attended with such a large measure of success.

Air Pollution from Chemical Works. — Mr. Alfred E. Fletcher, F.C.S., one of the inspectors under the Alkali Act. The author remarked that during the progress of many manufacturing processes gases or vapours were given off, which passing into the surrounding air, polluted it and rendered it more or less unfit for animal or vegetable life. If all noxious vapours were to be suppressed by the summary stoppage of the manufacturing processes causing them, we must dispense with the use of a variety of useful substances; indeed, it might be said that every manufacture was accompanied at its birth by some offensive smell or smoke. Still, the public were right in requiring that noxious vapours should be reduced to a minimum. Those who were not acquainted with manufactures would be surprised at the large amount of noxious vapours discharged from works. He then referred to the direction which he thought future legislation should take, his opinion being, he said, guided by the observations of Dr. Angus Smith, in his reports as chief inspector under the Alkali Act. In places where complaints were made against manufacturers by farmers, as to damage to their crops by corrosive smoke, let the district be called "a manufacturing district," upon the requisition of a certain number of inhabitants. To such district an inspector should then be appointed, who should have power at any time to ascertain the nature and amount of gases escaping from the various works. At the end of each month, or a longer period, the inspector should publish a list of all the works in his district, with a number indicating the average amount of acid vapour he had found upon his visits. There the inspector's duties should terminate, as he should be neither prosecutor nor judge, but merely publish the facts ascertained, which the farmer himself could never have gathered. He contended that such a plan would be beneficial in its operation. It would be universal in its application, and would embrace every description of manufacturing works. Hitherto legislation had been partial. There was an Alkali Act, but it regulated the alkali manufacture only.

In the discussion it was strongly urged that over-legislation on this question should be avoided, and that the crops do not suffer to the extent which was sometimes imagined. The Alkali Act had been so far beneficial as to call the attention of manufacturers to the subject of air pollution, and they had been induced to employ improved apparatus at their works.

On the Phenomena of the Crystallisation of a Double Salt.— Mr. J. Berger Spence. Mr. Spence said that hitherto many scientific chemists had doubted the possibility of producing soda alum; but the results of upwards of fifty experiments which he had made conclusively showed that this salt can be produced under certain circumstances. The principal point of interest in Mr. Spence's paper consisted in the discovery, made by him, that the crystals are produced from an amorphous mass, which is formed when the solution is prepared at high densities. The immediate result of this discovery may be that the large quantity of ammonia which is now used in the production of alum will be displaced in favour of soda, and that the valuable fertiliser, ammonia, which has no intrinsic value in alum, will be given to the soil, which, in an economic point of view, will be of considerable advantage to the country.

SECTION C.—GEOLOGY

Report on British Fossil Corals.—Prof. P. M. Duncan. The distinction between the palæozoic and later coral faunas was shown to be not so exact as was supposed, and that the aporose and perforate corals existed in the palæozoic rocks, as well as rugose and tabulate forms, which latter had closely allied recent analogues. The report contained a new classification of the Tabulata, and entered into the Alcyonarian characters of the *Chetetinæ* and the Hydrozoan characteristics of the *Milleporidæ.*

On the Fossil Elephants from Malta.—Dr. Leith Adams. After referring to his former reports, communicated to the Association in 1865 and 1866, in which the situation and nature of the Maltese ossiferous caves were described, Dr. Leith Adams now submitted further observations on the elephantine remains which has been collected by him in enormous quantities in those localities, and pointed out the important results that might be expected to flow from the comparison of these materials with those which had been brought by Captain Spratt from Zebbug, in which the late Dr. Falconer, in the year 1862, had discerned the existence of a dwarf or pigmy species, together with that of a larger form. Subsequently, Mr. Busk, on proceeding to work out Captain Spratt's collection in detail, found reason to discriminate three distinct forms, one of the average dimensions of the existing African and Asiatic species, and two others, differing from each other not only in size, but, as it would appear, in other osteological characters, but both of comparatively small or dwarf stature. The Zebbug collection, however, afforded but very scanty evidence with respect to the largest form, whilst that made by Dr. Leith Adams abounds with its remains, and will consequently allow of the correct determination of the true relations of that form with the two smaller forms found in association with it, as well as with other existing and extinct species, and especially with *E. antiquus*, whose relations up to the present time have remained obscure. Mr. Busk, by whom the paper was communicated, exhibited specimens selected from Dr. Adams' collection, proving the existence of the three forms above adverted to.

Report on the Exploration of Kent's Cavern.—Mr. W. Pengelly. During the past year the committee had investigated the only portions of the eastern division of the cave which had remained unexplored. Those portions had been called by the Rev. J. McEnery, the North and South Sally Ports in the belief that they led to external openings. The South Sally Port has a south-east direction into the hill, and away from the hill-side; it occupies a space of 80 feet by 40 feet. It was filled with, first, a red cave-earth from 12 to 20 inches thick; second, a stalagmitic floor from 1 to 24 inches thick; and third, a cave-earth of unknown depth, but exceeding 5 feet. The diggings yielded a large number of bones—including several birds and a few fish—portions of antlers, and about 1,400 fragmentary and perfect teeth, some of them still attached to the jaw-bones. The teeth belonged to the following animals :—Horse, hyena, rhinoceros, bear, sheep, badger, fox, rabbit, elephant, deer, lion, ox, hare, and pig. Agglutinated lumps of wings and elitra of beetles. Besides these, twenty-one flint implements and flakes were found. The North Sally Port covers an area of 86 feet by 84 feet, and passes out to an opening in the eastern slope of the hill. The three layers described in the South Sally Port are found in this opening also, and the remains obtained in the excavations were the same as and in like proportions to those found in the South Sally Port. Smerdon's Passage was determined to be the entrance to the North Sally Port, and also to a previously unsuspected passage. Numerous remains were found in this passage.

SECTION D.—BIOLOGICAL SCIENCE

Professor Rolleston's Inaugural Address. (Continued from p. 427.)

Pathology has made a return to Physiology for much service she has received, and this in the following directions. Dr. W. Ogle has thrown much light on the physiology of the cervical sympathetic nervous system by his record of a pathological history to be found in the recently issued volume (vol. lii.) of the "Medico-Chirurgical Transactions." The rough and cruel experimentation of war has had its vivisections utilised for the elucidation of the physiology of nerves, and especially of their trophic function, by the valuable volume issued by the American Sanitary Commission, under the editorship of Dr. Austin Flint. Dr. Broadbent has done something towards elucidating the question of the localisation of functions in particular parts of the cerebral convolutions which was so extensively and so very exhaustively discussed at Norwich by his paper in our most useful and comprehensive Cambridge "Journal of Anatomy and Physiology," May 1870, "On the Cerebral Convolutions of a Deaf and Dumb Woman."

I take this opportunity of mentioning two valuable papers on the very practical question of the influence of the vagus upon the heart's action. One of these is a German paper by a gentleman who is a zoologist and comparative anatomist as well as a physiologist, Dr. A. B. Meyer, "Das Hemmungsnervenssystem des Herzen" is the title of his memoir, a separate publication as I think; the other is an abstract of a paper [I have not seen the paper published *in extenso* as yet] by Dr. Rutherford, "On the Influence of the Vagus upon the Vascular System," published in the Cambridge journal just referred to. Especially do I think Dr. Rutherford's view as to the vagus acting centrifugally as regards the stomach, and carrying stimulus, not thither but thence, to the medulla oblongata, which stimulus is then radiated downwards by a route formed distally by the splanchnic nerve, so as to produce inhibitory vascular dilatation in the neighbourhood of the pepetic cells, as worthy of attention.* A considerable number of the papers which will be read before this Section, indeed a considerable part of the Section itself, will be devoted to the Natural History of Man. Nothing, I apprehend, is more distinctive of the present phase of that "proper study of mankind" than the now accomplished formation of a close alliance between the students of archæology strict and proper and the biologist with the express purpose of jointly occupying and cultivating that vast territory. Literature and art and the products of the arts furnish each their data to the ethnologist and anthropologist in addition to those which it is the business of the anatomist, the physiologist, the palæontologist, and the physical geographer, to be acquainted with; nor can any conclusion attained to by filling up any single one of those lines of investigation be considered as definitely absolved from the condition of the provisional until it has been shown that it can never be put into opposition with any conclusion legitimately arrived at along any other of the routes specified. In political alliances the shortcomings of one party necessarily hamper and check the advance of the other; a failure in the means or in the perseverance of one party may bring the joint enterprise to a premature close; mutual forbearance, not to dwell longer upon extreme cases, may finally be as effectual in slackening progress as even mutual jealousies. No such disadvantages attach themselves to the alliance of literature with science, as the German "Archiv für Anthropologie," issued to the world under the joint management of Ecker the biologist and Lindenschmidt the antiquarian, will show any one who consults its pages, replete with many-sided but not superficial, multifarious but never inaccurate, information.

The antiquary is a little prone, if he will allow me to say so, when left alone, to make himself but a connoisseur; the historian, whilst striving to avoid the Scylla of judicial dulness, slides into the Charybdis of political partizanship; and the biologist not rarely shows himslf a little cold to matters of moral and social interest, whilst absorbed in the enthusiasm of speciality. The combination of minds varying in bent is found efficacious in correcting these aberrations, and by this combination we obtain that white and dry light which is so comforting to the eye of the truth-loving student, to say nothing as to its being so much stronger than the coloured rays which the work of one isolated student has sometimes cast upon it from the work of another. It would be invidious to speculate, and I have forborne from suggesting whether the literary contingent in the conquering though composite army has learnt more from observation of the methods and evolutions of the scientific contingent, or the scientific man from the observation of the literary; it is, however, neither invidious nor superfluous to congratulate the general public upon the necessity which these, like other allies, have been reduced to, of adopting one common code of signals, and discarding the exclusive use of their several and distinctive technicalities. Subjects of an universal interest have thus come to be treated, and that by persons now amongst us, in a language universally understanded of the people. I have been careful to include the Palæontologist amongst the scientific specialists whose peculiar researches have cast a helpful and indeed an indispensable light upon the history of the fates and fortunes of our species. But it is not organic science only which anthropology impresses into its service, and it would be the sheerest ingratitude to forget the help which the Mineralogist gives us in assigning the source whence the jade celt has come or could come, or to omit an acknowledgment of the toil of the analytical chemist, who has given the percentage of the tin in the bronze celt, or in the so-called "leaden" and therefore Roman coffin.

I am very well aware that many persons who have honoured me by listening to the last few sentences, have been thinking that it is at least premature to attempt to harmonise the two classes of evidence in question; and that the best advice that can be given to the two sets of workers severally is, that they should work independently of each other. Craniography is said, and by irrefragable authority, to be a most deceptive guide; works and articles on ethnology tell us stories of skulls being labelled, even in museums of the first order of merit, with such Janus-like tickets as "Etruscan Tyrol *or* Inca Peruvian;" and one of the most celebrated anthropotomists of the day, has been so impressed with the fact that Peruvian as well as Javanese and Ethiopian skulls may be found on living shoulders within the precincts of a single German university town, that he has busied himself with forming a pseudo-typical ethnological series from the source and area just indicated. Great has been the scandal thence accruing to craniography, and the collector of skulls has thence come to be looked upon as a dilettante with singular ghoul-like propensities, which are pardonable only because they relate only to savage races of modern days, or to cemeteries several hundred years old, but which are not to be regarded as being seriously scientific. Now to me the existence of such a way of estimating such a work appears to argue a sad amount of ignorance of the laws of the logic of practical life, or, indeed, of the chapters on "approximate generalisations," which any man, however unpractical, can read in a treatise on logic. A man's features and physiognomy are instinctively and intuitively, or, if you prefer so to put it, as a result of the accumulated social experiences of generations of men, taken as a more or less valuable and trustworthy indication of his character; were this not so, photographers would not, as I apprehend, and hope they do; make fortunes, yet the face is at least as often fallacious as an index of the mind as the skull is fallacious as an index of race. The story of the misconception by a physiognomist of the character of Socrates is familiar to us, as I think, from Lemprière's Dictionary; and it may serve to parallel the story which Blumenbach and Tilesius tell us of the exact correspondence of the proportions of a skull from Nukahiva with those of the Apollo Belvidere. The living faces in a gaol again, to put the same argument upon other grounds, are as dangerous to judge from as are the skulls in the museum; yet every detective is something like a professor of physiognomy, and most of them could write a good commentary on Lavater. The true state of the case may, perhaps, be represented thus:—A person who has had a large series of crania through his hands, of the authenticity of which, as to place and data, he has himself had evidence, might express himself, perhaps, somewhat to the following effect if he were asked whether he had gathered from his examination of such a series any confidence as to his power of referring to, or excluding from, any such series, any skull which he had not seen before. He might say, "the human, like other highly-organised types of life, admits of great variety, aberrant forms arise, even in our own species, under conditions of the greatest uniformity possible to humanity; amongst savages great variety exists (see Bates, 'Naturalist on the Amazons,' ii. p. 129), even though they all of them may live the same 'dull grey life,' and die the same 'apathetic end;' and consequently it may never, except in the case of Australian or Esquimaux, and perhaps a few other crania, be quite safe to pledge oneself as to the nationality of a single skull. Still there is such a thing as craniographical type, and if half-a-dozen sets, consisting of ten crania apiece, each assortment having been taken from the cemeteries of some well-marked nationality, were set before me, I would venture to say, after consultation and comparison, especially with such assistance as that which an assembly such as this might furnish me with, that it might be possible to show that unassisted cranioscopy, if not invariably right, even under such favourable circumstances, was nevertheless not wrong in a very large number of cases." If it is true on the one hand that *in generalibus latet error*, it is true on the other that security is given us by the examination of large numbers for the accuracy and reliability of our averages, a principle which, Gratiolet informs us, is thoroughly recognised in Chinese metaphysics, and which he has formulated in the following words:—"L'invariabilité dans le milieu s'applique à tout. La verité n'est point dans un seul fait mais dans tous les faits; elle est dans les moyennes, c'est-à-dire dans une suite d'obstructions formalées après le plus grand nombre d'observations possibles." (Mémoire sur les Plis cérébraux, p. 93). The natural history sciences do not usually admit of the strictness which says that an exception, so far from proving a rule, proves it to be a bad one; rather are we wise in saying that in them at least the universality of assertion is in an inverse ratio to that of knowledge, and that the sweeping statements dear, as Aristotle long ago remarked (Rhetoric, ii. 21. 9 & 10.; ii. 22. 1.), to a class which he contrasts with the educated, are abhorrent to the mind of organic nature. It is true enough, as is sometimes said, that when opinions and assertions are always hooped in by qualifications, the style becomes embarrassed, and the meaning occasionally hard to be understood; but this difficulty is one which lies in the very nature of the case, and the real excellence of style does not consist in its lulling the attention and relieving the memory by throwing an alliterative ring on to the ear, but in the furnishing a closely fitting dress to thought, and an accurate representation of actual fact.

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* Since writing as above I have seen, but have not read, a paper by Dr. Coats in Ludwig's "Arbeiten aus der Physiologischen Anstalt zu Leipzig" for the present year. The Wurtzburg Physiological Laboratory Reports for 1867-1868, contain, as is well known, a series of papers on this subject.

If we are told that the attempt to harmonise the results, not merely of cranioscopy, but of any and all natural science investigation, with the results of literary and linguistic research, is needless and even futile, this is simply equivalent to saying that one or other of these methods is worthless. For as Truth is one, if two routes, purporting both alike to lead to it, do not sooner or later converge and harmonise, this can only be because one or other of them fails to impinge upon the goal. It is true that by certain lines of investigation light is thrown upon a problem, but at a single point, and that all further prosecution of investigation along that line will but lead us off at a tangent. Still the throwing of even a single ray upon a dark surface is an achievement with a value of its own; and it is a cardinal rule in our sciences never to ignore the existence of seemingly contradictory data, in whatsoever quarter they may show themselves. For what would be said of an investigator of a subject such as physical geography, who should declare that he would pay no attention but to a single set of data, when he was discussing whether a particular archipelago had been formed by upheaval, or should be held to be the fragments and remnants of a disrupted continent; and that if geological evidence was in crying discord with his interpretation of the facts of the distribution of species, it was not his business to reconcile them. He would be held to have neglected his business, as you may see by a reference to Mr. Bentham's Address to the Linnean Society, May, 24, 1869. (Linn. Soc. Proc. for 1869, p. xcii.[*])

The argument from identity of customs and practices to identity of race is liable to much the same objections and to much the same fallacies as is the argument from identity of cranial conformation. The case may be found admirably stated in Mr. Tylor's work on the "Early History of Mankind," p. 276, ed. 2, and I may say that the means of bringing the problem home to oneself may be found by a visit to any collection of flint implements. In such a collection as Mr. Tylor has pointed out, p. 205, we are very soon impressed with the marked uniformity which characterises these implements, whether modern or thousands of years old, whether found on this side of the world or the other. For example, a flint arrowhead which came into my hands a short time back, through the kindness of Lord Antrim, after having done duty in these iron times as a charm at the bottom of a water-tub for cattle in Ireland, was pointed out or at to me by a very distinguished Canadian naturalist, who was visiting Oxford the other day, as being closely similar to the weapons manufactured by the Canadian Indians. Now after such an experience one may do well to ask in Mr. Tylor's words ("Early History," p. 206):—

"How, then, is this remarkable uniformity to be explained? The principle that man does the same thing under the same circumstances will account for much; but it is very doubtful whether it can be stretched far enough to account for even the greater proportion of the facts in question. The other side of the argument is, of course, that resemblance is due to connection, and the truth is made up of the two, though in what proportions we do not know. It may be that, though the problem is too obscure to be worked out alone, the uniformity of development in different regions of the Stone age, may some day be successfully brought in with other lines of argument, based on deep-lying agreements in culture which tend to centralise the early history of races of very unlike appearances, and living in widely distant ages and countries."

If the psychological identity of our species may explain the identity of certain customs, its physiological identity may explain certain others. Some of this latter class are of a curious kind, and relate not to matters of social or family, but to matters of purely personal and individual interest, concerning as they do the sensibility, and with it, all the other functions of the living body. Such customs are the wearing of labrets, or lip-rings, nose-rings, and if I may add it without offence, of certain other rings, inserted in the wide region supplied by the fifth or tri-facial nerve. A physiological explanation may lie at the base of these practices, which appear to put at the disposal of the persons who adopt them a perennial means for setting up an irritation, whence reflex consequences in the course of reflex nutrition and reflex secretion, as of gastric juice, may flow. A curious book was written, or at least published, on the subject of these practices, and others akin to them, in 1653, by Dr. John Bulwer, a benevolent doctor, who paid attention to the care of the deaf and dumb previously, I think it is stated, to Dr. Wallis, and who consequently, with proper pride, if this precedence really belongs to him, signs himself "J. B. cognomento Chirosophus." The title of the book is "Anthropometamorphosis; Man Transformed, or the Artificial Changeling." I was made acquainted with its existence by my friend, Mr. Tomlinson, of Worcester College, from the library of which Society I procured a copy for consultation; the book is not rare I think; but I think it is little known, it contains much that is curious, and it is, inasmuch as it was written more than 200 years ago, *ὅτ' ἀκήρατος ἦν ἔτι λείμων*, from some, though not from all points of view, the more valuable. It is, I apprehend, to some of these customs, as well as to others, that Zimmerman—not the author of the work on Solitude, but Zimmerman the zoologist—alludes in a rather amusing passage, which may be found in the third volume of his larger work on the Distribution of Species, and on Zoology (see p. 257). I speak of the passage as amusing, it is more than that, or I would not quote it; indeed you will not see that it is particularly amusing unless I tell you that volumes ii. and iii. are of date 1783, and are dedicated to his own father, whilst volume i., of date 1778, is dedicated to "His Most Serene Highness and Lord, Ferdinand Duke of Brunswick, my Most Gracious Lord." Its quality of amusingness depends upon these dates, and the speculations they set us to make as to how the Duke had offended the man of science in the interval between 1778 and 1783. It may be a warning to Serene Dukes how they treat men of science. It runs thus :—"If you argue from similarity of customs and ceremonies to identity of origin of two tribes under comparison, you must first show that these customs are not such as would naturally tend to the amelioration of the conditions of the inhabitants in the two countries under consideration, and would probably therefore, or can naturally suggest themselves to each of the races in question. Or there may be customs founded on innate folly and stupidity, and thus, for your argument to be valid, you must show that of two peoples widely separated, each cannot by any chance come into its own country to adopt the like foolish and stupid customs. For whilst two wise heads are to make out, each independently of the other and contemporaneously, a wise discovery or invention, it is much more likely in the calculation of chances, and considering the much greater number of fools and blockheads ('Thoren und Dummköpfen') that in two countries widely apart, closely similar follies should be simultaneously invented. And then, if the inventing fool happens to be a man of influence and consideration, *which is, by the way, an exceedingly frequent coincidence*, both the nations are likely to adopt the same foolish practice, and the historian and antiquarian after the lapse of some centuries, is likely to draw from this coincidence the conclusion that the two nations both sprang from the same stock." Judge and speculate for yourselves how the spirit which breathes in this passage was excited, but note its scientific value too. We must not forget that it is possible, in thought, at least, to dissociate the psychological unity of man from his specific identity even ; and that as regards identity of race, it is only reasonable to expect that when similar needs are pressing, similar means for meeting them are not unlikely to be devised independently by members of two tribes who have for ages been separated from their original stocks. The question to be asked is, does the contrivance about which we are speculating, combine or does it not combine in itself so large a number of converging adaptations, as to render it upon the calculation of chances, unlikely that it should have been independently invented? Yet this very obvious principle has been neglected, or Lindenschmidt would not have found it necessary to say, that by laying too much stress upon certain points of national identity in the stones used for the formation of cromlechs or dolmens, the Hünenvolk might be made out to have chosen to settle only in those parts of Germany where erratic blocks of granite or other such large stones could be found! (Archiv für Anthropologie, iii. p. 115, 1868.)

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[*] The following references to passages of the kind referred to above as to the unreliability of craniographical evidence may be useful:—Geographisches Jahrbuch, 1866, p. 481. Hyrtl, Topograph. Anatomie, i. p. 13. Henle, System. Anat. i. 198. Krause, Archiv für Anthropologie, ii. 1. Holder, *ibid.* See also His and Rütimeyer, and Eckers in their systematic works severally, the Crania Helvetica, and the Crania Germaniæ meridionalis.

Sir John Lubbock's recently published work on "The Origin of Civilisation," may, I anticipate, cause the history and genealogy of manners and customs to enter largely into the composition of our lists of papers. There is no need for me, as the author of the book is here himself to speak, as announced, for himself, to occupy your time in recommending his work ; but I may be allowed to say that the utility of such pursuits as those which Sir John Lubbock's book treats of, receives some little illustration from the fact that, as we learn from him and from Mr. Tylor, the human mind blunders and errs and deceives itself in these subjects in just the same way as it does in the kindred, though more immediately arising, pressing and important matters of social and political life. In these latter spheres of observation we are apt occasionally to mistake one of those intermittent reactions of opinion, produced as eddies are produced in a river, by the deposit of sand and mud at angles in its onward course, for a deliberate giving up of the principles upon which all previous progress has been dependent. The straws which float upon the surface of a backwater may be taken as proofs that the river is about to flow upwards, and a feeble oarsman in a light boat may be deceived for some moments by the backward drifting of his small craft. Now an analogous blunder is often made in matters of purely historical interest ; and we may do well to learn from the experience thus cheaply earned. "The history of the human race has," says Sir J. Lubbock, p. 322, *l. c.*, "I feel satisfied, on the whole been one of progress ; I do not of course mean to say that every race is necessarily advancing ; on the contrary, most of the lower are almost stationary," but Sir John regards these as exceptional instances, and points out that if the past history of man had been one of deterioration, we have but a groundless expectation of future improvement, whilst on the other, if the past has been one of progress, we may fairly hope that the future will be so also.

Mr. Tylor's words are equally to the purpose, though as forming the end of a chapter merely, and that at the end of the book, they are less enthusiastic in tone. (P. 193, Tylor, "Early History of Mankind.") They run thus—

"To judge from experience, it would seem that the world, when it has once got a firmer grasp of new knowledge or a new art, is very loath to lose it altogether, especially when it relates to matters important to man in general, for the conduct of his daily life, and the satisfaction of his daily wants, things that come home to men's 'business and bosoms.' An inspection of the geographical distribution of art and knowledge among mankind seems to give some grounds for the belief that the history of the lower races, as of the higher, is not the history of a course of degeneration or even of equal oscillations to and fro, but of a movement, which, in spite of frequent stops and relapses, has on the whole been forward ; that there has been from age to age a growth in man's power over nature, which no degrading influences have been able permanently to check."

I must not trespass into the province of the Botanist, but I should be glad to say that no easier method of learning how the natural history sciences can be made to bear upon the history of man, as a whole, can be devised than that furnished by the perusal of such memoirs as those of Unger's upon the plants used for food by man. The very heading and title of the paper I am specially referring to appears to me to have an ambiguity about it which, in itself, is not a little instructive. In that title, "Botanische Streifzüge auf dem Gebiete der Cultur-Geschichte," the latter word may be taken, I imagine, etymologically at least, to refer either to culture proper or to agriculture. At any rate, the paper itself may be read in the Sitzungsberichte of the Vienna Academy for 1857 ; it has, I suppose, superseded the interesting chapters in Link's "Urwelt und Alterthum," of date 1821 ; and it is not unlikely, I apprehend, to be itself, in its turn, superseded also.

Coming, in the third place, to Zoology, I suppose I shall be justified in saying that the largest issue which has been raised in the current year, an issue for the examination of the data for deciding which the two months of July and August which are just past, may have furnished persons now present with opportunities, is the question of the kinship of the Ascidians to the Vertebrata. There is or was nothing better established till the appearance of Kowalewsky's paper, now about four years ago, than the existence of a wide gulph between the two great divisions of the animal kingdom, the Vertebrata and the Invertebrata ; nothing could be more revolutionary than the views which would obviously rise out of his facts, and within the present year these facts have been abundantly confirmed by Prof. Kupfer, whose very clearly written and beautifully illustrated paper has just appeared in the current number of Schultze's "Archiv für Microscopische Anatomie." Kupfer's researches have been carried on upon *Ascidia canina*, but they more than confirm the accuracy of what Kowalewsky had stated to take place in *Ascidia mammillata*, and which may be summed up briefly thus : In the larval Ascidian we have in its caudal appendages an axis skeleton clearly analogous, if not essentiallly homologous, to the chorda dorsalis of the vertebrate embryo, as consisting like it of rows of internally-placed cells, and giving insertion by its sheath to muscles. We have further the nervous system and the digestive taking up in such embryos much the same positions relatively to each other, and to this molluscan chorda dorsalis, that are taken up by the confessedly homologous system in the Vertebrata ; we have the nervous system originating in the same fashion and closing up like the vertebrate myelen-cephalon out of the early form of a lamellar furrow into that of a closed tube ; we have finally the respiratory and digestive inlets holding the vertebrate relationship of continuity with, instead of the invertebrate of dislocation and separation from each other. Such are the facts ; but I am not convinced that they will bear the interpretation that has been put upon them ; though I must say the possession of this chorda dorsalis by the active locomotor larva of the Ascidian which one day settles down into such immobility, lends not a little probability to Mr. Herbert Spencer's view of the genesis of the segmented vertebral column in animals undoubtedly vertebrate. But on this view I should not be inconsistent with myself, inasmuch as, to waive other considerations, the chorda dorsalis in each case would be considered as an adaptive or teleological modification, not a sign of morphological kinship. Much perplexity may or must arise here, and whilst entertaining these views, I felt myself bound to examine myself strictly to find whether in not taking them up, I might not be giving way to that reactionary reluctance to accept new ideas which advancing years so frequently bring with them ; but a recent paper, by Lacaze Duthiers, published in the *Comptes Rendus* for May 30, 1870, and translated in the Annals and Magazine of Natural History for July, 1870, would justify me, I think, in calling that reluctance by another name. For in that paper the renowned malacologist just mentioned has brought to light the fact that there is another sessile and solitary Ascidian, the *Molgula tubulosa*, which goes through no such tadpole-like stage, as had been supposed to be gone through by all Ascidians except the Salpæ, which is never active and never puts out the activity which is so remarkable in the other Ascidians, but settles down and remains sedentary immediately after it is set free from the egg capsula, neither enjoying a Wanderjahr *nor possessing a chorda dorsalis.* We are not surprised after this that M. Lacaze Duthiers observes that "although embryology may and must furnish valuable information by itself, it may also, in some cases, lead us into the gravest errors." Mr. Hancock, of Newcastle-upon-Tyne, has sent us a paper upon this subject, which will be read duly, and duly noted by us.

Leaving Malacology, which has not in the United Kingdom obtained the same hold as yet upon the public mind that it has on the Continent, where, like Entomology, there and here, it has a periodical or two devoted to the recording of the discoveries of its votaries, I have much pleasure in directing attention to two short papers by Siebold in the *Zeitschrift für wissenschaftliche Zoologie* (xx. 2, 1870), on Parthenogenesis in *Polistes gallica v. Diadema*, and on Pædogenesis in the *Strepsiptera.* In each of these short papers Siebold informs us that adequate room and time could not be given them in the Innsbruck meeting held just a year ago, or in the report of the meeting. It is to me a matter of difficulty to think what there could have been of greater value than those papers in a section of Wissenschaftliche Zoologie; it will be to all present a matter of congratulation to learn from the venerable professor's papers that he will shortly favour us with a new work on the subject of Parthenogenesis. A fresh instance of Parthenogenesis in Dipten, in *Chironomus*, has just been put upon record in the St. Petersburg Imperial Academy's memoirs (xv. 8, Jan. 13, 1870).

The subject of the Geographical Distribution of the various forms of vegetable and animal life over the surface of the globe, and in the various media, air, earth, water, fresh and salt, whether deep or shallow, has always been, and will always remain, one of the most interesting subsections of biology. It was the contemplation of a simple case of geographical distribution in the Galapagos Archipelago which brought the author of the "Origin of Species" face to face with the problem which the title of his work embodies; and it is impossible that sets of analogous and of more complicated facts,—many of which, be it recollected, such as the combination now being effected between our own Fauna and Flora and those of Australia and New Zealand, are patent to the observations of the least observing,—should not, since the appearance of that book, force the serious consideration of the explanation it offers upon the thoughts of all who think at all. The wonders of the Deep Sea Fauna will, I apprehend, form one, the Commensalism of Professor Van Beneden another, subject of discussion, and furnish an opportunity for receiving instruction to all of us. The one set of observations is a striking exemplification of the way in which organisms have become suited to inorganic environments, the other is an all but equally striking exemplification of the way in which organisms can fit and adapt themselves to each other. The current journals have,* as was their duty, made us acquainted with what has been done in both of these directions, and I am happy to say that in the case of the Deep Sea Explorations as in that of Parthenogenesis and Spontaneous Generation, a new work, giving a connected and general view of the entire subject, is announced for publication.

One instance of the large proportions of the questions which the facts of geographical distribution bear upon, is furnished to us in the address recently delivered before the Geological Society by its president, who is also our president, and who may have forgotten to refer to his own work (see NATURE, No. 24, 1870). Another may be found in the demonstration which Dr. Günther, contrary to our ordinarily taught doctrines, has given us (Zool. Soc. Trans. Vol. vi., pt. 7, 1868, p. 307) of the partial identity of the fish-faunas of the Atlantic and Pacific coasts of Central America; a third is furnished to us by Mr. Wallace's works *passim.*

It would be superfluous, after introducing even thus hurriedly to your notice so large a series of interesting and important subjects as being subjects with which we shall forthwith begin to deal in this Section, to say anything at length as to the advantages to be expected reasonably from the study of Biology. I may put its claims before you in a rough way by saying that I should be rejoiced indeed if when money comes to be granted by the Association for the following up the various lines of biological research upon which certain of its members are engaged, we could hope to obtain a one-hundredth, or I might say a thousandth part of the amount of money which has in the past year been lost to the State and to individuals through ignorance or disregard of biological laws now well established. I need say nothing of the suffering or death which anti-sanitary conditions entail, as surely as, though less palpably and rapidly than, a fire or a battle; and I might, if there were time for it, take my stand simply upon what is measurable by money. This I will not do, as it is less pleasant to speak of what has been lost than of that which has been or may be gained. And of this latter let me speak in a few words, and under two heads—the intellectual and the moral gains accruing from a study of the Natural History Sciences. As to the intellectual gains, the real psychologist and the true logician know very well that the discourse on method which comes from a man who is an actual investigator is worthy, even though it be but short and packed away in an Introduction or an Appendix, or though it cover but a couple of pages, like the "Regulæ Philosophandi" of Newton, more than whole columns of the "Sophistical Dialectic" of the ancient Schoolman and his modern followers. "If you wish your son to become a logician," said Johnson, "let him study Chillingworth"—meaning thereby that real vital knowledge of the arts and sciences can arise only out of the practice of reasoning; and as to the value of actual experimentation as a qualification for writing about method, Claude Bernard and Berthelot are, and I trust will long remain, living examples of what Descartes and Pascal, their fellow-countrymen, are illustrious departed examples. (See Janet, Revue de deux Mondes, tome lxii. p. 910, 1866.)

I pass on now to say a word on the working of natural science studies upon the faculty of attention, the faculty which has very often and very truly been spoken of as forming the connecting link between the intellectual and the moral elements of our immaterial nature. I am able to illustrate their beneficial working in producing carefulness and in enforcing perseverance, by a strong turning upon the use of, or rather upon the need for, a word. Von Baer, now the Nestor of biologists, after a long argumentation (Mem. Acad. Imp. Sci., St. Petersburg, 1859, p. 340) of the value which characterises his argumentations as to the affinities of certain Oceanic races, proceeds to consider how it is that certain of his predecessors in that sphere, or rather, in that hemisphere, as Mr. Wallace has taught us Oceania is very nearly, had so lamentably failed in attaining or coming anywhere near to the truth. This failure is ascribed to something which he calls "Ungenirtheit," a word which you will not find in a German dictionary, the thing itself not being, Von Baer says, German either. I am happy not to be able to find an exact equivalent for this word in any single English vocable, the opposite quality shows itself in facing conscientiously "the drudgery of details, without which drudgery," Dr. Temple tells us (Nine Schools Commission Report, vol. ii., p. 311), "nothing worth doing was ever yet done." Mr. Mill, I would add, speaks to the same effect, and even more appositely, as far as our purpose and our vocations are concerned, in his wise Inaugural Address at St. Andrews, p. 50. For the utter incompatibility of an ἀταλαίπωρος ζήτησις,—those two words give a Thucydidean rendering of "*Ungenirtheit,*"—with the successful investigation of natural problems, I would refer any man of thought, even though he be not a biologist, to a consideration of the way in which problems, as simple at first sight as the question of the feeding or non-feeding of the salmon in fresh water (see Dr. McIntosh, Linn. Soc. Proc., vii., p. 148), or that of the agencies whereby certain molluscs and annelids bore their way into wood, clay, or rocks must be investigated. It is easy to gather from such a consideration how severe are the requirements made by natural science investigations upon the liveliness and continuousness of our faculty of attention.

I shall speak of but one of the many purely moral benefits which may be reasonably regarded either as the fruit of a devotion to or as a preliminary to success in natural science. Of this I will speak in the words of Helmholtz, taking those words from a report of them as spoken at the meeting of the German Association for the Advancement of Science, which was held last year at Innsbruck. There Professor Helmholtz, in speaking of the distinctive characteristics of German scientific men, and of their truthfulness in particular, is reported to have used the following words:—

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* See NATURE, No. 39, July 28, 1870, and "Royal Society's Proceedings," Aug. 1870, for Deep Sea Explorations, and *Academy*, Sept. 10, 1870, for Commensalism.

"Es hat diesen Vorzug auch wesentlich zu verdanken der *Sittenstrenge* und *der uneigennutzige Begeisterung* welche die Männer der Wissenschaft beherrscht und beseelt hat, und welche sie nicht gekehrt hat an aussere Vortheile und gesellschaftliche Meinungen." These words are, I think, to the effect that the characteristics in question are in reality to be ascribed to the *severe simplicity of manners* and *to the absence of a spirit of self-seeking*, which form the guiding and inspiring principles of their men of science, and prevent them from giving themselves up to the pursuit of mere worldly advantages, and from paying undue homage to the prejudices of society. I think *Sittenstrenge* may be considered as more or less adequately rendered by the words *severe simplicity of manners*; at any rate, as things are known by their opposites, let me say that it is the exact contradictory of that "*profound idleness and luxuriousness*" which, we are told by an excellent authority (the Rev. Mark Pattison, "Suggestions on Academic Organisation," p. 241),—for whose accuracy I would vouch in this matter were there any need so to do,—"*have corrupted the nature*" of a large class of young men amongst ourselves, whilst *the absence of a spirit of self-seeking* is, in its turn, the contradictory of a certain character which Mr. Mill (*l.c.*, p. 90), has said to be one of the commonest amongst us adults, and to which Mr. Matthew Arnold has assigned the very convenient epithet of "Philistine." Investigation as to whether these undesirable tendencies are really becoming more rife amongst us, might be carried on with advantage in a place such as this, in the way of inquiries addressed to colonists returning home after a successful sojourn abroad. Such persons are able to note differences without prejudice, and, *ex hypothesi*, with unjaundiced eyes, which we are apt to overlook, as they may have grown up gradually and slowly. But, perhaps, researches of this kind are not quite precisely the particular kind of investigation with which we should busy ourselves; neither would the leaders of fashion, the persons with whom all the responsibility for this illimitable mischief rests, be very likely to listen to any statistics of ours, their ears being filled with very different sounds from any that, as I hope, will ever come from Section D. Whether men of science in England are more or less amenable to blame in this matter than the rest of their countrymen, it does not become us to say; but it does become and concern us to recollect that we have particular and special reasons, and those not far to seek, nor dependent on authority alone, for believing and acting upon the belief that real success in our course of life is incompatible with a spirit of self-seeking and with habits of even refined self-indulgence.

Department of Ethnology and Anthropology.—John Evans, F.R.S., in the chair.

Before commencing the business of the department, Mr. Evans offered a few remarks as to the subjects that properly came within the province of the department—the present condition of knowledge of those subjects, and the methods at command for increasing that knowledge. The subjects which may with propriety be brought under the consideration of the Department may approximately be defined as:—(1) all that relates to the antiquity of man, or the origin of the various races of mankind; (2) all that illustrates the progress and development of human civilisation; and (3) all that concerns the condition of the less civilised portions of the human race, even if not immediately connected with any general question of its origin or progress. The President then proceeded to show what an enormous field these subjects embrace, how much there is still to learn in the means of investigating them, notwithstanding the efforts of the numerous labourers, who have now for many years been employed in this field of research, and concluded a very interesting address by expressing his confidence that nothing would be said calculated to injure the feelings of any who, like ourselves, are in pursuit of truth, and that all will bear in mind how difficult it is to take in the whole of any single truth at one view, and how, of its many sides, two contending parties may each be seeing one only, and that possibly not the most important.

On the Principal Geological Changes which have occurred in Europe since the Appearance of Man.—Professor P. Martin Duncan, F.R.S., F.G.S., &c.

This short communication does not pretend to offer any new facts or opinions; but I trust that it will be found to be a truthful representation of the results of the more important labours of men who have laboured so sedulously and conscientiously on the subject of the antiquity of man. As such, I hope the paper will be of interest to the associates of the Section, although I cannot anticipate that it will yield any satisfaction to my more learned colleagues.

Most of the geological changes which have occurred since man first appeared in Europe are estimated and asserted in consequence of the results of direct observation upon the succession of phenomena which belong to the debatable ground between what is usually termed physical geography and geology. Some, however, are dependent upon the arguments which are brought forward by naturalists respecting the limitation and separation of parts of great natural history provinces.

For instance, if the remains of man or his early works are found in sediments high up on the sides of valleys, the sediments having been produced by the river when it flowed far above its present level, the vertical distance between the remains and the existing water-level affords evidence of geological or physico-geographical changes. And if a vast number of bones belonging to extinct and existing species of large animals, such as elephants and rhinocerides, hyænæ and lions, are found upon islands the area of which could not possibly have sustained and nourished the mammalia during life, the separation of the areas from the nearest continent is inferred, especially if the species are still existing there, or if their remains abound there.

It is necessary to premise that no trace of man has been found associated with any deposits which are formed during the Glacial Period in Northern Europe. The very nature of them would prevent such a discovery.

The loftiest mountains of Europe, such as the Alps, Pyrenees, Ardennes, and Vosges, underwent a great grinding down during the Glacial Period; and when it was over the results of this wear and tear were scattered far and wide all around them in the form of wash-down, gravel, and more or less angular stones. In a general view, this gravel, the result of the first glacialisation, is of the same geological age as the drift gravel of England north of the Thames, and of Northern Germany, which is called glacial drift, and which, as I have just observed, is older than the earliest traces of man in Europe. The earliest remains of man and his works, and of the beasts associated with him and hunted by him, rest upon these deposits, and are therefore later in time.

It would appear that man followed up the retreating ice of the north of Europe, for the remains of his works are found high up in many British valleys, which must then have begun to be formed by the natural drainage out of the deposits of the Glacial Period.

Now, after a time, there was another period of mountain glacialisation; and the glaciers of the Alps and Pyrenees, especially, extended far into the districts below them.

The grinding down of the mountain sides during this second glacialisation produced enormous quantities of mud and gravel; and when the glaciers retreated this detritus was washed far and wide over the plains. This deposit is constantly found to cover the remains of man and his works, and is therefore later in time.

The second glacialisation, and the dispersal of the wash-down, appears to form a rude line of separation between the Palæolithic Period, when man used rude stone weapons, and the Neolithic Period, when smooth or polished implements were made by him; and they also, in a general sense, mark the time when the great mammalia, the early prey of man, disappeared from the northern and western parts of Europe.

The following are the principal geological changes which occurred after the appearance of man in Europe:—

1. The subsidence of an area of land which connected Sicily with Crete and Northern Africa north of the Sahara.

2. The formation of a volcanic tufa on the hills bordering the present valleys of the Tiber and its tributaries; the excavation of those valleys by the river and its streams; the last eruption of the volcanoes of Latium, and their permanent extinction. The space included in the Roman territory has received its contour, and vast tracts near the coast have been worn away.

3. The formation of valleys in the Alpine detritus, which covered up large tracts of Northern Italy, and the re-excavation of old valleys, which had been more or less filled with the detritus. This great gravel was the wash-down of the wear and tear of the first extension of the south Alpine glaciers, and was, in a general sense, contemporaneous with the upper glacial drift of Northern Europe. It was deposited before man, as traced by his relics and works, lived in South Europe.

The dispersal of vast depths of silt and gravel over the plains into the valleys and far up the hill sides of the Sardinian States and Lombardo-Venetia, south, and to a certain extent south-east, of the Alps; the result of the wash-down of the wear and tear of the second extension of the Alpine glaciers; the formation of valleys in this gravel or silt, and the production of such heights as those which bound such plateaux as Rivoli.

4. Considerable local alterations in the relative level of land and sea along the west Neapolitan coast.

5. The formation of the straits of Gibraltar.

6. The excavation of such valleys as that of the Manganores in Central Spain, the formation of gravels containing flint implements and mammalian bones near Madrid, and therefore far beyond the influence of marine action.

7. The wearing down of many of the valleys to the north of the Pyrenees below the level of such lower mammaliferous caves as those in the neighbourhood of Tarascon; the dispersion of the results of the wear and tear of the second extension of the Pyrenean glaciers, and the filling up of the old valleys with it; the re-excavation of the valleys, and the carrying down of their silt or loess to the plains; the formation of streams and water-courses through this deposit.

8. The formation of certain valleys in the Perigord by streams to a certain extent, but principally by the gradual effects of rain, heat, frost, and other meteorological actions.

9. The excavation of the valleys of North and Eastern France, and the denudation and retrogression of their watersheds.

10. The dispersion of Alpine rocks, gravels, and rocks to the north of the Alps, produced by the wear and tear of the great glacialisation, which was, in a general sense, contemporaneous with the first extension of the glaciers south of the Alps, and the first extension of the Pyrenean glaciers, occurred before man appeared in Europe. After his first wanderings and huntings he left his remains above this old Alpine detritus. Then the valleys in the carboniferous limestone of Belgium were worn down ninety yards or more by rain and rivers, and the bones of the extinct mammalia and rude stone implements and bones of man were washed into caves with the gravel.

After the retirement of the glaciers, subsequent to this second extension, the wash-down of the Alps, Vosges, and Ardennes was spread over the older gravel. It filled up the valleys, and extended with a thickness varying from a few yards to a thousand feet and more, all down and over what is now the valley of the Rhine, Holland, and Belgium. The loess thus formed was then washed out of the valleys, was cut into by rivers, and has been worn down ever since.

11. The separation of the coasts of France and England about Dover and Calais.

12. The excavation of nearly all the valleys in the district east of a line drawn from King's Lynn to Portland, the denudation of their watersheds, and retrogression of the river sources.

13. The denudation of the valley of the Weald of Kent.

14. The separation of the Isle of Wight from the main land.

15. The formation of a great part of the Bristol Channel.

16. The upheaval of many sea beaches, and the general destruction of forest land on the south and west of England; the formation of many peats.

17. Enormous destruction of the sea coast.

18. A sufficient upheaval of the Scandinavian peninsula and Denmark, to produce such a restriction of the outlet as has determined a change in the marine fauna of the Baltic.

19. A slow upheaval of large areas appears to have accompanied the excavation of the valleys upon them, and a subsidence of equally large districts appears to have accompanied the recession of the second glaciers; probably another upheaval followed.

20. The uprise of the Desert of Sahara in Africa after the second extension of the Alpine glaciers.

SECTION E.—GEOGRAPHICAL SCIENCE

On Atmospheric Currents.—Mr. J. K. Laughton. In examining into the geographical distribution of winds, we must bear in mind that well-attested and careful observation is the only satisfactory basis, and that descriptions founded on theoretical opinions are of no value whatever. If we refer Hadley's Theory of the Trade Winds to this test, we find, *in the first place*, that the effect of heat in producing wind is not quite such as has been represented. Experimentally, heat does not produce a blast, unless the space between the heat and cold air be very confined, as is roughly shown by holding a newspaper before the fire. Geographically, heat does not cause a wind towards any of the principal areas of greatest temperature; either towards the Great African Desert, the Desert of Arabia, or of Australia, towards the Red Sea or the Persian Gulf, or even, when carefully traced, towards the Great Prairie of North America. *In the second place*, we find that the effect attributed to the rotation of the earth is not consistent with numerous observed facts, such as the S.E. wind in the Gulf of Mexico, the N.W. wind on the coast of North Africa, the N.W. gales in the North Atlantic, the S.W. wind on the south coast of Australia, and very many others; and, indeed, the idea appears to have originated in a temporary forgetfulness of the power of friction, which in the case of air and all fluids is very intense.

Winds, which, in accordance with Hadley's theory, have been very generally divided into *polar* and *equatorial*, seem more naturally to divide themselves into *easterly* and *westerly*; and it is this division which has, from the days of Columbus, been adopted by really practical men, to whom the winds were matters of fact, not of mere theory; but the trade-winds—having attracted early notice by their very great steadiness and regularity—have always been considered as the direct manifestations of the first cause, whatever it might be, of the great atmospheric movements; the westerly winds, which were not discovered till much later, having been considered as secondary and comparatively of little importance. But, as our experience grows larger, we learn that the westerly winds have an extent and a strength and a rude vigour incompatible with the idea of their secondary nature. Whether in the northern or southern hemisphere, they are exceedingly violent and boisterous; and, without considering the Arctic and Antarctic regions, concerning which we have not sufficient evidence, they extend from 60° N. to 60° S., interrupted only by the trade-winds, which blow over an area large indeed, but small *in comparison* with that on which they intrude. The trade-winds are also of very limited height, whilst above them the westerly winds blow as strongly as they do in the temperate zones, where they reach into the upper strata of the atmosphere as far as we have any knowledge. We are thus led towards the conclusion that the westerly winds are really the primary winds, far extending and boisterous; whilst the quiet equable trade-winds—of very limited volume—are reflex streams of air caused by the impact of the great westerly winds on the continental barriers, whether against mountain ranges or the more sluggish air which lies over the land. The Atlantic Ocean affords us the most familiar illustrations of this; where we see the main westerly stream dividing on about the parallel of 45° N., and turning north, as a south-westerly wind on our coasts, and the coast of Norway; or south, as a north-west and northerly wind on the coast of Portugal, and a north-easterly on the coast of Africa; whilst the rest of it forces its way onward, a westerly wind over Northern Europe and Asia, or a northerly deflection in the several basins of the Mediterranean. On the other hand, on the extreme west, the westerly wind continually dragging away the air from the eastern side of the Rocky Mountains, causes such a tendency towards a vacuum, that the air from the south and north is induced towards it, and the wind over Western America rules from the south or north, according as the season throws the axial line of the temperate zone to the north or south of its mean position. Examining at great length into the various local winds and irregularities in the different parts of the world, we arrive at the conclusion that the whole atmosphere has a continued tendency to move from west to east, and does so more when it is not interrupted. The interruptions are of two kinds: one occasional and irregular, being caused by fluctuations in the hydrostatic condition of the air, the other permanent or seasonal and regular, caused by the pressure of lines of coast and mountain ranges.

It is impossible to say definitely why the atmosphere should have this prevailing motion; but if the cause is neither heat nor the influence of the earth's rotation, nor any agency which we can detect at work on the earth, we are driven almost insensibly to the belief that it must be the result of celestial attraction; and the fact that the barometer shows no trace of any noteworthy rise or fall, as of an atmospheric tide, suggests that the atmospheric currents, which must necessarily be formed by the action of such an intense disturbing force, do not in any way clash, but flow uninterruptedly onwards in one certain direction, either towards the east or towards the west. All observation shows us that there is not a permanent current towards the west, but that there is one towards the east; and although we are unable at present to master all the details of the manner of the motion, the evidence of geographical fact, combined with that of astronomical possibility, justifies us in inclining towards the belief that the motive force for which we are seeking is really the disturbing force of the attraction of the heavenly bodies.

SECTION G.—*Mechanical Science.*—President, Mr. Charles B. Vignoles, F.R.S., Pres. C.E.

In his introductory address, bearing chiefly on railway development and the defence of the country, the President remarked that that day, the 15th of September, was the anniversary of an event in which Liverpool played a most important part forty years ago. The opening of the Liverpool and Manchester Railway was entirely owing to the high public spirit shown by the merchants of Liverpool. At that time the ways and means of communication were so completely crippled that the trade of Liverpool would have become paralysed, had not better, speedier, and cheaper means of communication been created, and especially by the opening of the railway connecting Liverpool and Manchester. In this great work Liverpool took the lead ; and it was particularly owing to the zeal of one of Liverpool's most distinguished citizens, the late Mr. Henry Booth, who was the original secretary of the railway company, and to the energy and scientific knowledge which he brought to bear upon the question of railways, that attention was paid to the improvements of the steam-engine, which was now performing such wonders both at home and abroad. He (the President) thought the people of Liverpool had not shown themselves sufficiently grateful to the memory of Mr. Henry Booth in allowing his name to lapse, as it were, from public recollection ; but he was glad to have been invited to a meeting held in Liverpool a short time ago, at which a subscription was inaugurated for the raising of a statue to that eminent man and successful worker in mechanical science. The subscription list needed only a little addition to complete this most desirable object. Liverpool was peculiarly appropriate for this meeting of the British Association, for that Association and the railway system might be said to have had their birth in the same year, both having originated just forty years ago. He had himself taken part in laying down the Liverpool and Manchester Railway, and felt a special interest in this anniversary. The President then went on to mention the principal subjects which would be discussed in that Section. He next referred to the position of this country in regard to the means and preparedness for military defence, and as to the military service of England. He might, perhaps, be disabusing the minds of many persons who had supposed that the Government of this country was not prepared or was not alive to the necessity of creating the best means of internal communication, in the event of war or invasion of the country, when he mentioned to them that for several years past the military authorities had been in constant communication with the chief engineers of the country, and had formed deliberate arrangements, by which, in the event of such a casualty as a military invasion of England, within forty-eight hours the military forces of the whole country, say 100,000 men, might be brought down upon any given point that might be attacked. Therefore they might feel reassured as to the position of England in case of an invasion. As an old soldier himself, he had, at the request of the Government, treated this question, and had shown completely that within twelve hours of the alarm of invasion at any given point, the rolling stock of the railways of the country could be applied for concentrating all the military resources of the country upon the point threatened. He had stated in Liverpool forty-one years ago that the institution of railways would have this very result ; and it had been practically exemplified in the war that was raging on the Continent. On Tuesday, he might mention, papers would be read upon the construction and stability of ships by some of the most distinguished men in the country, bearing upon the most unfortunate accident that had occurred to the ironclad steamship *Captain*, to the causes of which the attention of the whole scientific world was now being directed.

REPORT OF THE COMMITTEE ON BOILER EXPLOSIONS

Mr. Lavington E. Fletcher, C.E., reporter. The other members of the Committee were Sir William Fairbairn, Bart., C.E., F.R.S., LL.D., &c. ; Sir Joseph Whitworth, Bart., C.E., F.R.S. ; John Penn, C.E., F.R.S. ; Frederick J. Bramwell, C.E. ; Hugh Mason, Samuel Rigby, Thomas Schofield, Charles F. Beyer, C.E. ; and Thomas Webster, Q.C., F.R.S.

In concluding their report, the committee stated that they decidedly incline to the plan of enforcing inspection directly by law rather than indirectly by penalty. They are not without apprehensions that, however ingeniously the principle of joint-stock insurance might be surrounded with a series of checks and counter-checks, yet that it would lead to inspection being cut down to the lowest possible point. On the other hand, were the inspection enforced by law, and nationally administered either by a central steam board or by a series of district ones, they consider that a far more generous system would be secured. The steam boards, uninfluenced either by private or local interests, or by the desire to accumulate profits, would take altogether higher ground, and inspect, not simply in their own interests, and just sufficiently to narrowly escape explosion, but with a view to assist steam users, disseminate practical information on the making and management of boilers, and promote progress. These objects would be altogether foreign to competing joint-stock insurance companies. The committee hold the view that, had coroners' verdicts been as satisfactory as they might have been, boiler explosions would not have been as numerous as they now are. With the additional experience of another year they feel compelled to take one other step in advance, and they have come to the conclusion that the time has arrived when the Government should enforce the periodical inspection of all steam boilers. They are convinced that explosions might be, and ought to be, prevented ; that competent inspection is adequate for this purpose, and that any well-organised system of inspection extended throughout the entire country would practically extinguish boiler explosions, and save the greater part of the seventy-five lives now annually sacrificed thereby.

A paper on the same subject was read by Mr. E. B. Marten, C.E., and the discussion was taken upon both communications. The speakers were Sir William Fairbairn, Mr. Siemens, Sir Joseph Whitworth, Messrs. Hawksley, Bramwell, Rigby, Longridge, Gray, Mallet, Sir William Armstrong, and the President. In summing up, the President remarked that many accidents were attributable to the dishonest construction of boilers. English habits seemed to kick against anything like Government interference, but such accidents as had arisen from boiler explosions should be put an end to as forcibly as possible—like stamping out the smallpox or the cattle plague, notwithstanding vulgar prejudices—if necessary, by an iron hand. The Government should pass a law making the inspection of boilers compulsory.

On Mechanical Stoking.—Messrs. James Smith and J. and T. Vicars, Liverpool. The paper is too long to reproduce here, but we may mention, in reference to the method described in it, that Mr. L. E. Fletcher, C.E., of the Steam Users' Association, remarked that he had witnessed some very carefully-conducted trials with the apparatus as against very careful hand-firing, and that he could testify that the furnace was perfectly smokeless, and in every respect attained good results.

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ERRATA.—Page 391, col. 2, the asterisk referring to first foot-note should have been placed after the word "feet," line 33—Page 393, col. 2, line 5 from bottom, for "Cyclus" read "Cyclas" ; line 2 from bottom, for "Surg." read "Surv."—Page 408, col. 2, Contents, for "G. D. De Rance" read "C. E. De Rance."—Page 423, col. 2, line 34 from bottom, for "this" read "their" ; line 6 from bottom, for "Gaskell's" read "Quekett's"—Page 424, col. 1, line 30 from bottom, for "*gradatium*" read "*gradatim*" ; col. 2, line 4, for "Loca" read "Local" ; line 6, for "this" read "the" ; line 5 from bottom, for "Darwin's" read "Damon's"—Page 425, col. 1, line 5, for "conjuvat" read "conjurat" ; line 8 from bottom, for "*Ajax* or" read "*Ajax* of" ; col. 2, line 28, for "which" read "who"—Page 426, col. 1. line 13, for "war" read "woe" ; line 34 from bottom, for "knotgrass, cowgrass" read "knotgrass *s.* cowgrass" ; line 24 from bottom, for "*porcena*" read "*porcina*"—Page 427, col. 1, line 1, for "Bichamp" read "Béchamp" ; line 17 from bottom, for "may come when" read "may, when" ; col. 2, line 35, for "inhalistic" read "vitalistic" ; line 36, for "useful" read "vital" ; line 37, for "involve" read "resolve" ; line 39, for "ordered" read "resolved."